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(21) International Application Number: PCT/FI97/00131 (22) International Filing Date: 27 February 1997 (27.02.97) (30) Priority Data: 960971 1 March 1996 (01.03.96) FI (71) Applicant (for all designated States except US): NESTE OY [FI/FI]; Keilaniemi, FIN-02150 Espoo (FI). (72) Inventors; and (75) Inventors/Applicants (for US only): ILVES, Antti [FI/FI]; Kometinkatu 1 as. 44, FIN-53810 Lappeenranta (FI). LINDSTRÖM, Matti [FI/FI]; Kuusimäenkatu 1A, FIN-53810 Lappeenranta (FI). (74) Agent: FORSSÉN & SALOMAA OY; Yrjönkatu 30, FIN-00100 Helsinki (FI).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: HEAT TRANSFER FLUID (57) Abstract The invention relates to a heat transfer/cooling fluid for low temperatures. The heat transfer/cooling fluid contains trimethyl glycine 15...70 % and water 30...85 %. The heat transfer fluid of the invention is environment-friendly and non-toxic, it has good heat transfer properties, and it is suitable, for example, for the needs of the food industry and for solar panels.		

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Heat transfer fluid

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The invention relates to a heat transfer/cooling fluid for a wide range of uses, especially for heat transfer uses presupposing environment-friendliness and health viewpoints, for example non-toxicity and a wide temperature range.

10 Heat transfer/cooling fluids are commonly used in industry, technical installations in buildings, refrigeration equipment and motor applications.

Good heat transfer properties are important in heat transfer/cooling fluids. This presupposes a good specific thermal capacity, thermal conductivity and pumpability.

15 A low viscosity value at low temperatures is typical of heat transfer fluids, because in such a case the fluid can be brought into a turbulent flow with a lower pump power.

In addition to the above properties, important properties of heat transfer fluids often
20 also include environment-friendliness and non-toxicity, in particular when used in the food industry and in the heating of household water. The heat transfer fluid must not be in any way harmful to the products being processed. Slight leakages of the fluid into the process could cause severe accidents. Therefore non-toxicity of the fluid is one of the most crucial factors.

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The most typical fluids are organic and water-containing heat transfer/cooling fluids. The problem with organic fluids is the difficulty in their use and their toxicity. With respect to most of its properties, water is a nearly perfect heat exchange fluid. It has good heat transfer and pumpability properties. In addition, water is completely non-
30 toxic and non-hazardous to the environment. In addition, it is in no way flammable. Indeed, the major disadvantage of water is the narrow temperature range for its use.

As is known, water freezes at 0 °C and boils at 100 °C. Furthermore, water causes corrosion, especially in connection with iron-containing materials.

As to the state of the art regarding heat transfer fluids used at low temperatures,
5 reference can be made to, for example, *EP application publication 0641849*, which discloses a heat transfer fluid composition comprising an alkylmethysiloxane fluid or a combination of alkylmethysiloxane fluids and various fluids based on polydiorganosiloxane with terminal trimethylsilyl groups.

10 The most typical water-based heat transfer fluids are aqueous mixtures of ethylene glycol, propylene glycol and ethanol. Ethylene glycol is one of the best known heat transfer fluids, and it is used in particular in the automobile industry. However, the use of ethylene glycol has disadvantages in that the substance is toxic and is not very environment-friendly. Propylene glycol is indeed often used instead of ethylene
15 glycol in applications in which less toxic properties are required. Although propylene glycol is relatively non-toxic, it is, nevertheless, a substance which pollutes the environment. One disadvantage of propylene glycol is the great increase in its viscosity at low temperatures; this increases the required pump power.

20 The non-toxicity of ethanol as compared with ethylene glycol is an advantage in its use, but its use has the disadvantage in its great volatility and consequently in its constituting a fire hazard and great increase in its viscosity at low temperatures, the latter being, however, more advantageous than with propylene glycols. For this reason ethanol is a commonly used substance as a heat transfer fluid in laboratories
25 and in conditions requiring non-toxicity. However, the use of ethanol involves the problem that it requires permits from the health authorities, a factor which complicates the use of this fluid.

Corrosion, in particular in the case of glycols, has forced users to seek expensive
30 and effective corrosion inhibitors. The monitoring of the composition and concentration of corrosion inhibitors is difficult. In general, an effective inhibitor makes an

otherwise highly non-toxic liquid toxic. Typically complicated solutions increase the cost of the end solution.

5 As regards the state of the art associated with corrosion inhibitors, reference can be made to *EP application publication 0369100*, which discloses a heat transfer fluid which contains a dicarboxylic acid mixture as a corrosion inhibitor and in which the cooling fluid composition comprises a water-soluble liquid alcohol to lower the freezing point; for example ethylene glycol and a mixture of glycol and diethylene glycol have been used in that capacity.

10

The goal of the present invention is to provide a heat transfer/cooling fluid in which the problems and disadvantages of state-of-the-art options have been eliminated, or at least substantially minimized.

15 It is an object of the invention to provide a heat transfer/cooling fluid which is suitable for use at low temperatures and which is safe in terms of health and the environment and technically economical to use.

20 The heat transfer/cooling fluid according to the invention is primarily characterized in that it contains trimethyl glycine or a derivative thereof 15...70 % and water 30...85 %. The most typical cooling fluid according to the invention contains trimethyl glycine 35 %.

25 A preferred compound for use as a component in the heat transfer fluid is trimethyl glycine or salts of trimethyl glycine hydrate. An especially preferred compound is trimethyl glycine, i.e. betaine. The latter can be prepared by isolating it from natural products, e.g. sugar beet; this enables a heat transfer fluid of a biologic origin, having an advantageous life cycle, to be prepared.

30 The heat transfer/cooling fluid according to the invention has the advantages of non-toxicity and simplicity. Its physical properties are the same as those of glycol solutions. The heat transfer/cooling fluid according to the invention is suitable for

use at temperatures of $-50...+100\text{ }^{\circ}\text{C}$. A preferred temperature range in heat pumps and in refrigeration equipment is $-40...+70\text{ }^{\circ}\text{C}$. Furthermore, a heat transfer/cooling fluid according to the invention withstands boiling, which occasionally occurs in solar panels.

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Together with the heat transfer/cooling fluid according to the invention it is possible to use conventional corrosion inhibitors, stabilizing agents and marking agents, necessary at a given time, which are well known in the art.

- 10 The heat transfer/cooling fluid according to the invention is less toxic and more environment-friendly than known cooling fluids. It is not classified as a problem waste, and its easy destruction decreases the costs. The handling of the waste of a heat transfer fluid according to the invention does not require special measures; it can be absorbed into soil or be run into a drain, whereas the ethylene and propylene
- 15 glycols and ethanol used in state-of-the-art options have to be treated either at a problem waste treatment plant or under the supervision of public authorities.

The heat transfer/cooling fluid according to the invention is suitable for use in various applications, especially in those in which the temperatures are low and which

20 require the fluid to be environment-friendly and non-toxic, for example in the food industry. Some applications which can be mentioned include solar heat systems, heat pumps, refrigeration equipment, ventilation and air-conditioning equipment, in which in particular heat or cold is recovered from the exit air and is transferred to the inlet air. One application which can be mentioned is solar panels.

25

Example 1

The toxicity of the fluids was assessed on the basis of LD_{50} values obtained from the literature. The LD_{50} values used have been tested orally on rats. The values are

30 shown in Table I.

Table I

Material	LD ₅₀ /mg/kg
Ethylene glycol	4 700
Propylene glycol	20 000
Ethanol	7 060
Trimethyl glycine	11 179

10 **Example II**

The viscosity values of fluids at the same concentrations are compared in Table II. Table III shows a comparison at a concentration corresponding to a freezing point of -15 °C. The freezing point is the temperature at which the first crystals are formed in the solution.

Table II

Fluid	Concentration wt%	Kinetic viscosity mm ² /s			
Temperature		20°C	0°C	-10°C	-20°C
Ethylene glycol	50	3,48	7,40	11,7	19,6
Propylene glycol	50	6,44	18,70	38	87
Ethanol	50	3,10	7,22	12,20	23
Trimethyl glycine	50	5,90	12,80	21,50	38

Table III

Fluid	Concentration wt%	Kinetic viscosity mm ² /s			
		20°C	0°C	-10°C	-15°C
Ethylene glycol	30,5	2,1	4,3	6,5	8,2
Propylene glycol	33	3,3	7,8	14,4	20
Ethanol	24,5	2,5	5,9	10,9	15,8
Trimethyl glycine	35	2,1	5,1	11	17,2

Example III

The lowering of the freezing point for various solutions at a concentration of 50 wt. % is shown in Table IV.

Table IV

Fluid	Freezing point for a 50 wt. % solution / °C
Ethyl glycol	-35
Propyl glycol	-34
Ethanol	-38
Trimethyl glycine	-43

The invention is described above with reference to only a few of its preferred examples; however, the purpose is not to limit the invention strictly to the details of the examples. Many modifications and variations are possible within the inventive idea defined in the following patent claims.

Claims

1. A heat transfer/cooling fluid, **characterized** in that the heat transfer/cooling fluid contains 15...70 % of trimethyl glycine or derivatives thereof and 30...85 % of water.
5
2. A heat transfer/cooling fluid according to Claim 1, **characterized** in that the heat transfer/cooling fluid contains salts of trimethyl glycine hydrate.
- 10 3. A heat transfer/cooling fluid according to Claim 1, **characterized** in that the heat transfer/cooling fluid contains trimethyl glycine.
4. A heat transfer/cooling fluid according to Claim 1, **characterized** in that the heat transfer/cooling fluid contains 30...50 % of trimethyl glycine and 50...70 % of water.
15
5. A heat transfer/cooling fluid according to Claim 1, **characterized** in that the heat transfer/cooling fluid contains approximately 35 % of trimethyl glycine and approximately 65 % of water.
20
6. A heat transfer/cooling fluid according to any of the above claims, **characterized** in that the temperature range of use of the heat transfer/cooling fluid is - 50...+100 °C.
- 25 7. A heat transfer/cooling fluid according to any of the above claims, **characterized** in that the temperature range of use of the heat transfer/cooling fluid is - 40...+70 °C.
8. A heat transfer/cooling fluid according to Claim 4, **characterized** in that the heat transfer/cooling fluid contains trimethyl glycine of a biologic origin.
30

9. The use of the heat transfer/cooling fluid according to Claim 1 in solar systems, heat pumps, refrigeration equipment, ventilation equipment and air-conditioning equipment.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00131

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C09K 5/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C09K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

STN: REGISTRY, CA; QUESTEL: EDOC, WPIL, JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0379175 A1 (THE DOW CHEMICAL COMPANY), 25 July 1990 (25.07.90), claim 1 --	1-9
A	DE 1044843 B (SIEMENS-ELECTROGERÄTE AKTIENGESELLSCHAFT), 27 November 1958 (27.11.58) -- -----	1-9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0379175 A1	25/07/90	AT 123053 T AU 632785 B AU 4855790 A CA 2007912 A DE 69019539 D,T ES 2072319 T JP 2269195 A US 5021180 A	15/06/95 14/01/93 26/07/90 18/07/90 21/09/95 16/07/95 02/11/90 04/06/91
DE 1044843 B	27/11/58	NONE	